Omnidirectional photonic crystals for visible light control

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Photonic crystals with a bandgap in the visible frequency regime are important for creating new generations of photonic devices for lighting, displays, lasers and sensing. Ultimate control of light is possible if a complete omnidirectional gap can be achieved, a considerable challenge in the visible and ultraviolet frequencies. This is mainly due to fabrication complications in integrating transparent, high refractive index (n) materials to create ~ 100 nm periodic structures with long range translational order. Self-assembly techniques used to achieve visible PCs have resulted only in directional gaps due to limitations imposed by material and geometry (e.g., inverse opal). We have demonstrated a nano-lithography approach based on electron-beam direct write and physical vapor deposition to fabricate PCs with complete three dimensional band gap in the visible frequencies. We will discuss the fabrication of an "Iowa State woodpile" photonic crystal with titanium dioxide rods with lattice constant in the 300nm –400nm range with ~ 100nm-160nm minimum feature size (figure.1). In addition to the full optical characterization of the photonic crystals we will also investigate the control of light emission from visible light sources such as quantum dots and dyes embedded inside these structures.

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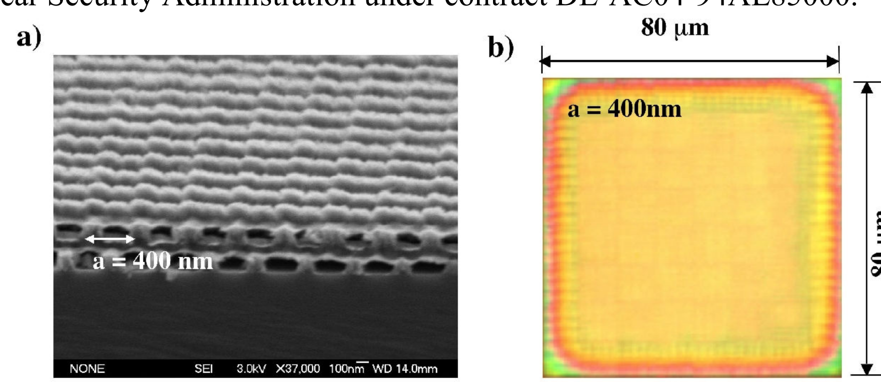

Figure1: a) Cross-section scanning electron microscope image of a= 400nm woodpile lattice. b) Corresponding optical microscope image of the sample